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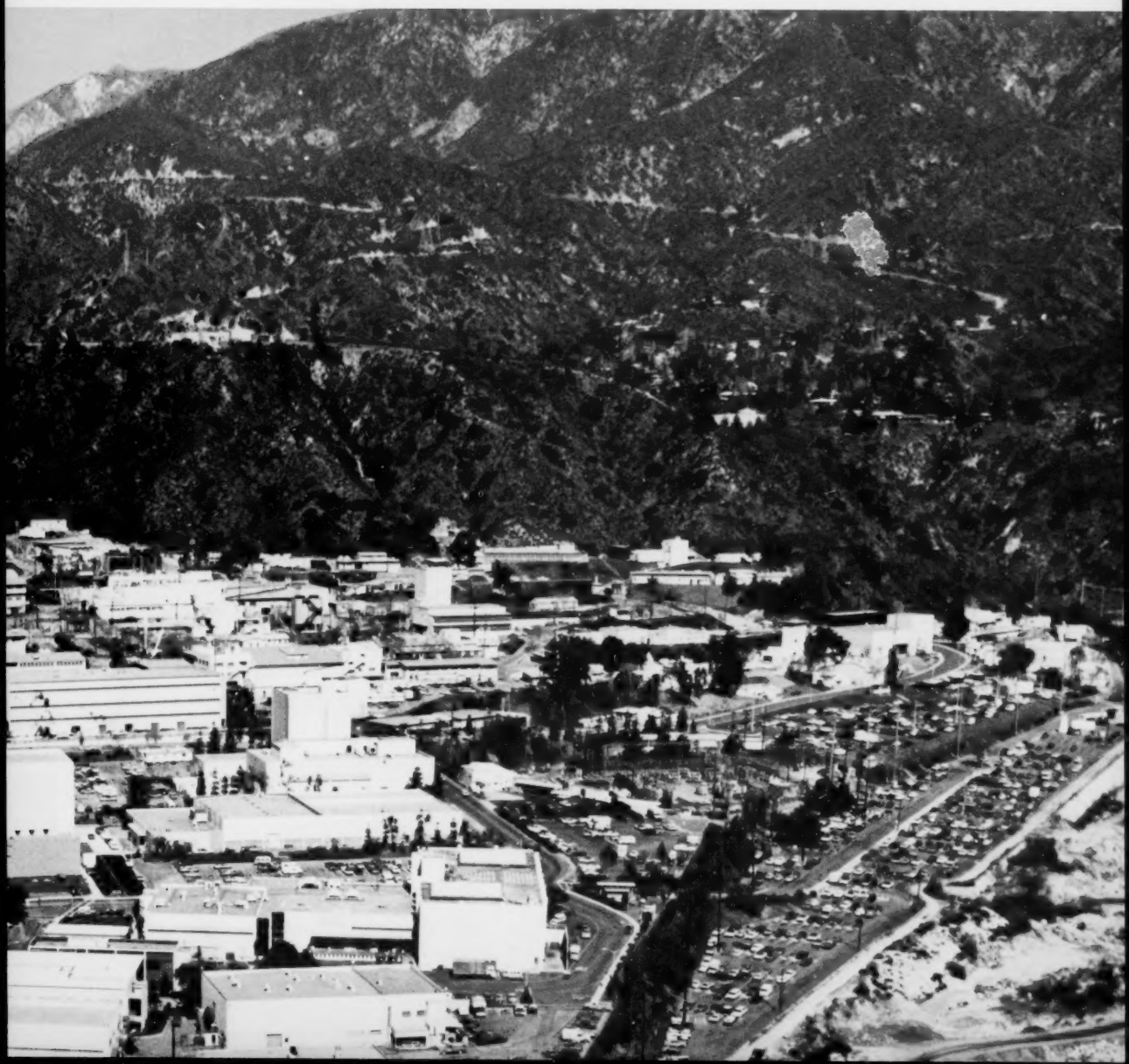

Cover

NASA's Jet Propulsion Laboratory occupies 177 acres of land at Pasadena, Calif., of which 146 are owned by NASA and 31 acres are leased. The laboratory is set in the foothills of the San Gabriel Mountains, about 20 miles northeast of Los Angeles. JPL operates the Deep Space Communication Complex, a station of the worldwide Deep Space Network, located at Goldstone, Calif. on 40,000 acres occupied under permit from the Army. Edwards Test Station, a facility at Edwards Air Force Base for propellant processing and testing, and Table Mountain are other major California sites operated by the NASA laboratory.

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Letter from Washington

Dear Colleagues:

With two Pioneer and two Voyager spacecraft exploring the outer planets; with two Vikings continuing to relay data back from Mars; with HEAO scanning the universe for X-ray and gamma ray sources; with two Helios orbiting the Sun; and with firm plans afoot to probe the atmospheres of Jupiter and Vensus and to orbit a large Space Telescope—this seems an appropriate time to reaffirm our commitment to all this space activity, the philosophy which underlies it, and the goals we seek.

In the most basic sense, what we are doing, it seems to me, is what we as humans have always done —seeking knowledge, seeking to know. Somewhere at our species' core is a special need to know—know ourselves, know our planet, know the universe if we can. Always we have taken great risks, committed huge resources to add to the sum of our knowledge. Over the centuries determined men have voluntarily risked their lives to explore the Earth's most hostile and inaccessible places, the poles, the peaks, the open oceans, the jungles and the deserts; they have descended into the deeps of the sea; risen in balloons to the stratosphere; and blasted into space in tiny capsules on the tips of rockets. Always they have gone into the unknown and made it known; always the frontiers of human knowledge have been pushed outward.

It is this continuing search for knowledge which has taken us from the first faltering flights down the dunes of Kitty Hawk to the craters of the Moon in only two-thirds of a single century.

Voyager, Viking, Pioneer, Helios and the HEAO spacecraft, with their arrays of sensors and sophisticated instruments, are in reality questing extensions of ourselves. The Space Telescope, when it begins its observations in the mid-1980s, will be the direct intellectual and scientific descendant of Galileo's original instrument, different in degree of technological advancement but identical in philosophy and intent. All these sophisticated devices are simply continuing a process as old as Man and almost as instinctive as the search for food and shelter—the process of exploration, of converting the unknown into the known for the advancement of the species.

And that advancement has been in direct proportion to the degree of knowledge gained. Historically the benefits to humanity from new knowledge have most often been inconceivable to the individuals who made the discoveries or to their contemporaries, and the interval between discovery and application has been long—but the benefits have always come and they have changed the world.

Two thousand years ago it was discovered that certain ferrous ores and metals exhibited a peculiar property which we have come to know as magnetism. Twelve hundred years later that property first became useful for navigational purposes (the compass) and led to the discovery of new worlds and the dramatic expansion of human knowledge. In the last century and a half, discovery of the basic significance of magnetism to the structure of matter has become the basis for much of our present-day technology.

Twenty centuries elapsed between the discovery of conic sections and their application to engineering problems, more centuries between the discovery that ether could be used as an anesthetic and its actual use, a full century between the invention of the agricultural combine in 1830 and its first use in 1930.

Leonardo da Vinci worked out the basic principles of aerodynamics around the turn of the sixteenth century. But it was 400 years before the Wright brothers added the internal combustion engine and man left the ground for the first time in powered flight.

An important part of our mission at NASA is to reduce this time lag between knowledge and application, between the feasible idea and its practical use, and we are having considerable success accelerating the rate of change in our society in the process. What practical benefits will accrue to our descendants a century or two in the future from the explorations now in progress we cannot know. History tells us they will be immense and our daily papers tell us they will be needed.

With the prospect of planetary shortages of resources and energy, a deteriorated environment and a surplus of human beings, we will need all the knowledge we can get about other resources,

other energy sources, and the nature and mechanics of the atmosphere in which we live.

That knowledge is out there, and we are pursuing it in a variety of ways. Seven of the nine planets and several large satellites have atmospheres that provide natural laboratories in which we can acquire essential knowledge about our own planet.

Understanding the nature of the solar wind and its interaction with planetary magnetospheres will help us ultimately to understand the ways in which solar activity affects our own climate.

Solar studies from deep space can eventually lead to knowledge from which technologies can be derived to deliver solar energy to Earth economically, harmlessly and in essentially unlimited quantities.

Knowledge of the asteroids eventually can make available to Mankind huge quantities of almost pure iron and nickel.

These are only the *practical* benefits we can see with reasonable clarity from our place in time. Inevitably there will be innumerable others, less immediate, less direct yet far more significant in their influence on the future of our planet and its inhabitants.

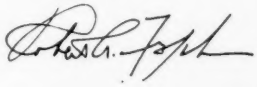
Finally what we are doing is, in the simplest terms, the very best kind of science, science in the sense of a sustained accretion of human spirit and as the response of humanity's inquisitively creative mind to the challenge of the mysteries of creation, matter, energy and life.

The late scientist and poet Loren Eiseley has written that "the reality we know in our limited lifetimes is dwarfed by the unseen potential of the abyss where science stops."

What we are doing for all of humanity, in our own limited lifetimes, is expanding the frontiers of that reality and diminishing at least to some degree the dimensions of the abyss.

I can conceive of no more worthy work.

Sincerely,



Robert A. Frosch

Two Voyager Spacecraft Finally In Successful Flight

The first Voyager satellite was launched on Aug. 20—though not without certain difficulties—followed by a successful launch of its sister craft on Sept. 5. Difficulties involving the deployment of a boom on the first Voyager essential to the success of the mission, then a stubborn refusal of the spacecraft to obey orders sent from Earth, caused a seven day-long delay in the launch of the second Voyager, originally scheduled for Sept. 1, while NASA's Jet Propulsion Laboratory scientists and engineers tested and re-tested the Voyager systems.

At the news conference following the Sept. 5 launch of Voyager 1 (called by old NASA hands the briefest in the history of NASA press briefings), project manager John Casani, when asked what he had to say about the flight, replied: "Nothing." And that was the logical answer.

The weather was perfect, the sky a dazzling, cloudless blue, the launch was perfectly executed, and the unusual visibility allowed watchers to see the vehicle clearly right up to the point at which the solid rocket strap-ons were jettisoned, setting Voyager on its endless flight.

All kinds of observers were on hand for the dramatic launch: 7,700 people, on a hot Labor Day, watched from nearby causeways; some 300 news-people from many places recorded the event via radio, television, newspaper and magazine; and, as if to add to the explosive beauty of the launch, a flock of rare roseate spoonbill birds soared in wild abandoned flight silhouetted against the blazing launch pad. The afterblast rattled windows as far away as Cocoa Beach, some 20 miles from the launch site.

Two celebrities from foreign lands unexpectedly turned up to view the launch. President of Paraguay Alfredo Stroessner arrived in his own Electra jet along with a coterie of 50. The group rose and cheered as Voyager roared into flight. (NASA watchers say that President Stroessner was the first head of state to view a launch since Apollo 17.) The second foreign VIP present was Bishop Canius Van Lierde, Vicar General of the Vatican, a close servitor to the Pope.

Riding atop a Titan Centaur rocket, the Voyagers were launched from the Kennedy Space Center on a decade-long odyssey that could take them to as many as 15 major heavenly bodies. These include giant Jupiter and ringed Saturn, several moons of both planets and possibly Uranus.

Making measurements and taking closeup pictures, the Voyagers will return information that could shed new light on the origin and early history of the solar system and our own planet earth.

Voyager 2 was launched first and Voyager 1 second, because Voyager 1 will fly a faster trajectory than its companion and reach Jupiter in March, 1979, four months before Voyager 2. Upon its encounter with Saturn, Voyager 1 will be about nine months ahead of its sister craft.

At Jupiter, the gravity-assist technique—using a planet's gravitational field to speed up a spacecraft and change its trajectory—will be used to send the Voyagers on to Saturn. This "slingshot" technique will enable Voyager 1 to arrive at Saturn in late summer of 1980, 3.2 years after launch. Without making such use of Jupiter's massive gravity, the flight from Earth would require 6.1 years. When it reaches Saturn, Voyager will have traveled 2.2 billion kilometers through space.

After completing their planetary missions, the two spacecraft will continue outward from the solar system and across the boundary of the wind of charged particles (solar wind) that streams outward from the Sun, thus penetrating into interstellar space.

The Voyager spacecraft are advanced versions of planetary explorers that have studied Mercury, Venus and Mars. The new craft weigh 825 kilograms each. The spacecraft differ from their Mariner and Viking predecessors in many respects—differences dictated primarily by the environment into which they will venture and the great distances across which they must communicate with Earth. Because the amount of sunlight that strikes the outer planets is only a small fraction of that which reaches Earth, the Voyagers cannot depend on solar energy but must use nuclear power—radioisotope thermoelectric generators. The Voyagers are dominated by the largest communications antennas—3.7 meters in diameter—yet flown on planetary missions.

They are the first planetary spacecraft to carry an expendable solid-fueled propulsion module for use during launch. After launch, 68,000-newton-thrust solid-propellant rocket motors on the propulsion modules placed the spacecraft on their flight paths to Jupiter. They use steering thrusters for trajectory corrections. Some trajectory correction maneuvers will require engine burns of more than an hour, sometimes as long as several days.

Each Voyager uses 11 instruments including the spacecraft radio to study the planets, their satellites, the rings of Saturn, the magnetic regions surrounding the planets and interplanetary space. The instrument payload weighs 105 kg.

The Voyagers carry wide-angle and narrow-angle television cameras, cosmic ray detectors, infrared spectrometers and radiometers, low-energy charged-particle detectors, magnetometers, photo-polarimeters, planetary radio astronomy receivers, plasma and plasma wave instruments and ultraviolet spectrometers.

The television cameras will provide pictures of Jupiter and Saturn of greater resolution than any taken from Earth or by the earlier Pioneer 10 and 11 spacecraft. They will study Jupiter for eight months. The cameras also should take the first high-resolution, closeup photos of the Galilean satellites of Jupiter, the major satellites of Saturn and Saturn's rings. (Pioneer 11 is now on a trajectory which will take it through Saturn's rings in 1979, but the pictures taken—if any—will have 100 times less resolution than the Voyager images.)

Other Voyager instruments will study the atmosphere of the planets and their satellites, their magnetosphere and the relationships between these regions and the solar wind that streams through interplanetary space, and the radio signals from Jupiter (which emits the strongest radio noise in our sky except for that of the Sun). Other objectives include all-sky surveys of interplanetary space and gravitational fields.

An option is being maintained to send Voyager 2 on to the planet Uranus, 20 times farther from the Sun than Earth. Encounter, which would occur in January 1986, would permit the first closeup examination of the recently discovered rings of Uranus. The Uranus option will be exercised only if primary goals of Saturn have been met by the first Voyager and the operating condition of the second Voyager warrants the added four-year trip.

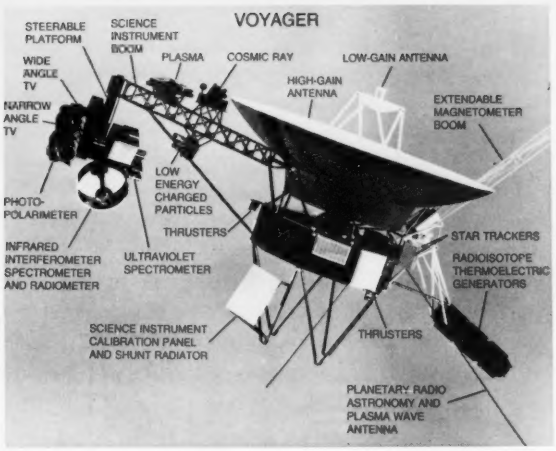
The Voyager spacecraft receive a large increase in velocity as a result of their close flyby of the planet Jupiter. This gravity-assist velocity increase allows the spacecraft to reach Saturn in the relatively short time of 3.2 to 4 years with a launch vehicle that is only slightly larger than required for Jupiter missions. This opportunity to send a spacecraft to Saturn following a close flyby of Jupiter occurs approximately every 20 years. The opportunity for the Uranus option is the result of the alignment of Jupiter, Saturn and Uranus which happens only once every 45 years.

Project Voyager represents the next step in the United States program of systematic planetary exploration in which the solar system is used as a natural laboratory. By being able to compare the similarities and differences of the various planets, scientists expect to learn more about the processes that affect the Earth and better understand the history of the solar system.

Until recently, our knowledge of Jupiter and Saturn was only rudimentary. Ground-based studies by optical infrared and radio astronomy defined the most basic properties of Jupiter and Saturn and their satellites and hinted at the unique scientific potential of these systems.

In 1973 and 1974 a first close-up look at Jupiter and its system was provided by two Pioneer spacecraft. As Pioneers 10 and 11 sped past Jupiter, their instruments began to reveal the complexity of its atmosphere and the extent and strength of the Jovian magnetosphere. Voyager is the

Beginning a Fantastic Voyage—The Voyager-1 satellite was launched atop Titan/Centaur-6, from NASA facilities (launch complex 41) at Cape Canaveral, joining sister spacecraft Voyager-2, on a years-long mission to the outer planets.



next logical step in the exploration of the Jovian system. Also, by carrying out detailed exploration of Saturn, the Voyager spacecraft will provide a fascinating perspective for detailed comparisons of a host of unfamiliar worlds.

Jupiter and Saturn are the largest planets. Together with their many satellites they dominate the solar system. The diameter of Jupiter is 10 times that of Earth, and it contains more matter than all of the other planets put together. With its retinue of 13 moons, four of them as large as planets, Jupiter is actually the center of a miniature solar system.

Saturn also has a system of many satellites and includes, in addition, two unique features—a spectacular ring system which appears to be composed mainly of tiny pieces of ice and snow; and one large satellite, Titan, with an atmosphere as massive as that of the Earth. In any program of planetary exploration study, of the Jovian and Saturnian systems is of paramount interest for understanding the origin and evolution of the solar system.

Despite their great size, Jupiter and Saturn are mysterious worlds. Both are giant balls of gas with no apparent solid surface. Both are composed largely of hydrogen and helium. These planets best represent the original materials from which the Sun and all the planets—including Earth—were formed. Jupiter and Saturn constitute miniature but uniquely accessible laboratories for study of phenomenon of wide-range astrophysical interest.

Like the stars, Jupiter and Saturn each has its own internal energy sources, radiating nearly twice as much energy as they receive from the Sun. As Pioneer 10 and 11 measurements revealed, Jupiter has a strong magnetic field and is surrounded by radiation belts similar to the Van Allen belts around the Earth. The vast, rapidly spinning magnetosphere and radiation belts of Jupiter make it a major source of several types of radio radiation.

The atmospheres of these giant planets are driven by the same forces that act on Earth's atmosphere, but on a much larger scale. Major cyclones, like the Great Red Spot of Jupiter, are thousands of miles across and persist for centuries. Their atmospheres contain multiple cloud layers each with their own temperature and chemical composition.

The four largest satellites of Jupiter—Io, Europa, Ganymede and Callisto—provide a varying and fascinating microcosm of unique worlds. Some are composed largely of rock, some of ice, some of

Protection for Voyagers—The two Voyager satellites were protected on their bumpy rides to outer space by a six-story shroud. After the Voyagers left Earth's atmosphere, an "explosive can opener" called SuperZip separated the three-ton shroud from the spacecraft and booster rocket. When detonated by an electrical impulse, the SuperZip tube, filled with explosives, expanded to burst the shroud at its seams and let it fall away from the spacecraft. Since all explosive material remains in the tube, it could not contaminate the satellite. Lockheed Missiles and Space Co. built the shroud at its Sunnyvale (Calif.) plant.

water. Their surfaces probably range from lunar-like cratered plains, to salt-covered beds of extinct seas, to exotic landforms created out of ice and mud. In ice and water-dominated regimes, familiar geologic processes will take place thousands of times faster than on a rocky planet. Totally unfamiliar geologic forms are expected as well. Most satellites of Saturn are apparently also composed primarily of ice, but Titan, the largest satellite in the solar system, also has an atmosphere similar in size to that of the Earth's though significantly different in composition.

Scientists believe that organic molecules are being created today in the atmosphere of Titan and that this strange, cold satellite may even provide clues to the origin of life on Earth.

The three spectacular rings that surround Saturn may be the remains of a satellite that came too close and was broken up by the strong tidal forces of the planet or they may be remnants of material from the birth of the solar system that never coalesced to form a large moon.

Jupiter orbits the Sun at a distance of 778 million km. One Jupiter year equals 11.86 Earth years. Jupiter's day is less than 10 hours long. Saturn orbits the Sun at a distance of 1.42 billion km. It completes one orbit every 29.46 Earth years. A day on Saturn is 10 hours and 14 minutes long. The widest visible ring of Saturn has a radius of 136,000 km.

The closest approach of a Voyager to Jupiter, estimated as March 5, 1979, will be about 278,000 km from the visible cloud surface of the planet. Both Earth and Sun will disappear behind Jupiter, as seen from the spacecraft (occultation), allowing scientists to make new measurements of the structure and composition of the planet's upper atmosphere from atmospheric effects on Voyager radio signals as they pass through the Jovian atmosphere enroute to Earth.

After passing Jupiter, Voyager 1 will examine all four of the large Galilean satellites. Observations of Jupiter will continue for a month after closest approach, until early April 1979.

Voyager 2 will begin its observatory phase of Jupiter about two weeks later, 80 days before closest approach as did Voyager 1. It will observe four satellites during the inbound leg: Callisto, Ganymede, Europa and Amalthea.

The spacecraft will make its closest approach to Jupiter on July 10, 1979. Following a more distant course than its predecessor, the second Voyager will pass more than twice as far from the planet, 643,000 km away. The second Jupiter encounter will continue into August.

The first Saturn encounter will begin in August 1980 and will continue through December. On the inbound leg, Voyager 1 will pass within 4,000 km of the major satellite Titan. Closest approach to Saturn—138,000 km—will occur Nov. 12, 1980. Titan, Saturn and the rings will all block out the Sun and Earth as seen by instruments on the spacecraft to provide occultation measurements.

The second Saturn encounter will begin in June 1981. Closest approach will occur Aug. 27, 1981. Voyager 2 will observe the satellites Titan, Rhea and Tethys on its inbound journey, and Enceladus at closest approach. Encounter will continue through September.

Tracking and data acquisition will be performed by the Deep Space Network (DSN) with stations in California, Australia and Spain. At planet encounter, high-rate data will be received through the DSN's 64-m antenna subnet. Maximum data rate at Jupiter will be 115,000 bits per second, at Saturn 44,800.

NASA's Office of Space Science has assigned Voyager project management to Jet Propulsion Laboratory, which is managed for NASA by the California Institute of Technology. NASA program manager is Rodney Mills and the JPL project manager is John Casani. Dr. Milton A. Mitz is NASA program scientist and Dr. Edward C. Stone of Caltech is project scientist. JPL designed, assembled and tested the Voyager spacecraft.

Voyager's solid rocket motor is provided by the NASA Goddard Space Flight Center's Delta Office. Prime contractor is Thiokol Chemical Corp.

Launch vehicle responsibility has been assigned to NASA's Lewis Research Center. Prime contractors to Lewis are Martin Marietta Corp., Denver, Colo., (the Titan) and General Dynamics/Convair, San Diego, Calif., (the Centaur).

Tracking, communications and mission operations are conducted by JPL, which operates the Deep Space Network for NASA's Office of Tracking and Data Acquisition.

The spacecraft's radioisotope thermoelectric generators are provided to NASA by the U.S. Energy Research and Development Administration. Prime contractor to ERDA is General Electric Co., Valley Forge, Pa.

Estimated cost of the Voyager project, exclusive of launch vehicles, tracking and data acquisition and flight support activities is $320 million.

Five Years of Astronomy Observations

Twenty-seven thousand orbits and 1,175 million kilometers of space travel after its launch Aug. 21, 1972, a spacecraft named Copernicus continues to provide the world's scientific community with new information which already has contributed to solving astronomers' age-old questions about the origin and evolution of the universe.

From its "astronomical arena" 749 km above Earth, the 2,300-kilogram observatory is measuring star light that never reaches Earth-based observatories because of the shielding effect of Earth's atmosphere.

Copernicus was named after the famous Polish astronomer Nicolaus Copernicus 400 years after he was born. He revolutionized astronomy by postulating that the Sun, not the Earth, was at the center of the then known solar system. The spacecraft carries two telescopes. One is provided by Princeton University, the other by the University College of London, England. The two telescopes have measured the ultraviolet and X-ray light from thousands of stars and interstellar dust the past five years.

Scientists are especially pleased by Copernicus's ability to be available for experimentation 98 percent of the time. This makes it possible to make about 25 observations daily. Approximately 6,000 observations have been made during the past five years.

Copernicus has become a "space age companion" to astronomers on nearly every continent. To date the list of active guest investigators has reached about 150, and almost 200 scientific papers have been printed in scientific and popular journals. Those subjects include such facts as the following:

- Deuterium (heavy hydrogen) has been detected and studied in many places in space. Its measured abundance has proven valuable in supporting the big bang theory of the origin of the Universe.
- Chromospheres and coronae have been detected and analyzed in many cool stars. This has greatly expanded an entire field of astronomy hitherto confined almost entirely to the Sun.
- Powerful winds of hot gasses have been seen being blown away from hot stars, carrying enough of the stars' material to affect the life cycle of such stars.
- Several comets have been observed.
- Many observations have been made of Mars, Jupiter, Io (one of Jupiter's moons), Saturn, and Titan (Saturn's largest moon) returning important data about their atmospheres. These data will be compared with known information about Earth's atmosphere.
- Nova Cygni was observed for two weeks in 1975. The data imply that this particular nova was quite unusual.
- The constituents of the Earth's atmosphere, such as ozone and hydrogen, are being studied and monitored with time. One discovery was of a larger than expected abundance of night-time ozone.
- Observation of three new Sun-like stars in efforts to find out whether other civilizations may be trying to contact our solar system via ultra-violet laser beams.
- Studies of interstellar gas and dust clouds which form new stars and continue the process of transferring the primeval hydrogen into the heavy elements that make up our bodies and the world about us.

Copernicus has provided man with a plentitude of knowledge of the Universe even more than was hoped for on that August day five years ago when it left Earth to study the cosmos for "the benefit of all mankind."

Second Spacelab Flight Gains Participants

Experiments devised by 59 scientists have been selected to participate in the second Spacelab flight to be launched into Earth orbit aboard NASA's Space Shuttle in 1981. Forty-seven of the scientists will represent the United States and 12 the United Kingdom. The group was chosen by NASA from more than 1,000 candidates who responded to invitations to participate in the mission. The selected scientists held a planning meeting at the Marshall Space Flight Center in early September.

The primary objective of the second Spacelab flight is to verify the performance of Spacelab systems and subsystems, and to measure the environment surrounding the Space Shuttle.

The secondary objective is to obtain scientific, applications and technology data and to demonstrate the broad capability of Spacelab to perform space research. Astronomy, high energy astrophysics and solar physics research will be emphasized on this flight. Experiments also will be performed in plasma physics, botany and medicine.

Spacelab 2 will consist of four 3-meter pallet segments exposed to space in the orbiter cargo bay. In addition to serving as a mounting platform for the experiment instrumentation, the pallets will provide power, thermal conditioning, data and other services to the instruments.

The Marshall center has the leading role for NASA in the Spacelab development program and also has been assigned the payload mission management responsibility for the first three Spacelab missions. The European Space Agency (ESA) is responsible for the construction of Spacelab.

Spacelab 2 will be launched from NASA's Kennedy Space Center, and will remain in the Shuttle Orbiter's cargo bay as it orbits the Earth for up to 11 days at an altitude of about 400 kilometers with an inclination of 57 degrees.

After the Space Shuttle Orbiter reaches its proper orbit, the necessary Spacelab systems will be activated and tested for proper operations. Then the scientists aboard the spacecraft (called payload specialists), working with the orbiter crew and the scientific and technical investigators on the ground, will perform various experiments until shortly before the Spacelab systems are shut down in preparation for a return to the landing site. The two payload specialists, operating from the Orbiter's aft flight deck, will work complementary shifts so that scientific experimentation can continue 24 hours a day.

The solar terrestrial division in NASA's Office of Space Science has management responsibility for the Spacelab 2 payload. W. R. Witt, Jr., is the program manager and Dr. J. D. Rosendhal is program scientist. The Marshall center, has been assigned project management responsibility, with R.E. Pace as mission manager and R. C. Lester as assistant manager. Dr. E. W. Urban is the mission scientist.

The experiment complement is expected to provide new scientific results in a number of areas. In astrophysics, information will be obtained on technical composition of very high energy cosmic rays, on the spatial distribution of X-ray emitting material in clusters of galaxies, on the existence of diffuse, cool objects in our own galaxy, on the abundance of helium in the Sun and on the time evolution of small scale solar features, and the possible relation between changes in solar velocity and magnetic fields.

Spacelab and the Space Shuttle are capable of carrying massive instruments (cosmic ray physics, X-ray astronomy), for making optimum use of combinations of instruments to study specific problems (solar physics), for using instrumentation requiring the physical return of data and equipment (solar physics, infrared astronomy), for using people as an integral part of the experiment control system (solar physics), and for using the Shuttle itself as part of an active experiment (space plasmas).

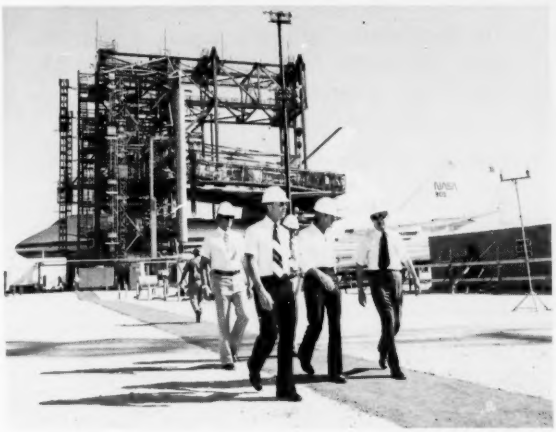
Fares for Travel on Space Shuttle

"How much does it cost to fly on the Space Shuttle?"

That is an often asked question and one to which NASA is paying a great deal of attention. NASA plans to begin Shuttle operation flights in 1980. The answer to the question of price ranges from less than $10,000 to more than $21 million, depending on how much the cargo weighs and what volume is involved, whether a reservation has been made or the flight is on standby basis and what optional services are desired.

Passengers?

(continued on page 11)



Administrator Visits—During a recent visit to the Dryden Flight Research Center, Dr. Robert A. Frosch (right) was given a briefing and center tour by (background) Dan Jenson, Rockwell International ALT manager and Isaac Gillam, deputy director of the center; David Scott, center director and Deke Slayton, ALT manager are in foreground. The Space Shuttle can be seen in background.

"No, not yet," NASA's space transportation system operations director, Chester M. Lee says. "Non-astronaut payload specialists may fly on some missions to conduct experiments and operate equipment but we're not ready to book tourists yet."

Lee notes that the Space Shuttle will carry as many as seven people on a flight. Three of these will be crew member astronauts supplied by NASA —pilot, co-pilot and mission specialist. The other four would be payload specialists, assigned by the customer for the mission.

At the low end of the fare structure is the so-called "get-away special" which permits an individual or organization to fly a payload in the Shuttle on a space-available basis for $10,000 or less. To qualify for this low fee the proposed payload must involve research, weigh less than about 90 kilograms, have a volume of less than five cubic feet and be self-contained. Any services cost extra.

The $21 million fare is for using the full capacity of the Space Shuttle on a reservation basis by non-U.S. government customers.

In between are charges made for customers sharing the Shuttle flight with other customers, willing to fly on a stand-by basis, and customers who have made a substantial investment in the Space Transportation System development. The latter category includes the European Space Agency, its member nations and Canada. ESA is developing the Spacelab to be carried within the Shuttle and Canada is developing the remote manipulator system that will be used in the Shuttle.

Lee says the pricing policies are designed to encourage full use of the Shuttle by making the charges economically attractive while recovering the total operating costs incurred by NASA. Also, for commercial and foreign users, there is a use fee that covers depreciation of facilities and equipment and amortizing of orbiters.

"After three years of operation we plan to reexamine prices to determine whether operating costs are being recovered and to make adjustments if necessary," Lee said. He added that the policy contains an escalator clause to account for increases caused by inflation.

Reduced price incentives for payloads having exceptional merit and added charges for short-term call-ups, postponements or cancellations are on the agenda. Lower rates are offered for standby payloads, for floating launch date options and for reserving space on future missions.

"Our policies also make it possible for several users to share a Shuttle flight, sharing the price of the flight at a fraction of the cost of the total mission," Lee said. Charges for shared flights will be based on the size of the payload and its destination.

The NASA policy covers subletting of space in the Shuttle and includes standard services such as design, safety reviews, flight planning, provision of a three-person crew and transmission of payload data. Optional services available for additional cost include special crew training, upper stages and services, special mission kits, revisit and retrieval of satellites and special equipment.

Looking Over the Enterprise—The Space Shuttle orbiter was a highlight of California State Senator Walter Stiern's recent tour of NASA's Dryden center. The orbiter, mounted atop its Boeing 747 carrier aircraft, was undergoing preparations for its first free flight in the approach and landing tests at the time. Protocol officer John Rantal (r) briefed the Senator on the major programs at the NASA facility. Aid Bob Sogge (l) and Mrs. Stiern accompanied the Senator.

All HEAO-1 Experiments A-OK

All scientific experiments aboard NASA's first High Energy Astronomical Observatory have now been turned on and are operational, according to Dr. Fred A. Speer, HEAO manager at the Marshall center.

Both the observatory, which was launched from the Kennedy Space Center Aug. 12, and its ground support systems, are operating as planned. Data being obtained from the observatory already indicate the acquisition of X-ray sources, Speer said.

Real-time data are being forwarded to the home facilities of the various principal investigators whose experiments are aboard HEAO-1. Principal investigators are reported quite pleased with the early performance of their instruments.

A team of MSFC and TRW Corp. engineers are controlling the observatory from a control center designed and built by engineers at the Goddard Space Flight Center.

HEAO-1, the heaviest unmanned Earth-orbiting satellite ever launched, is carrying a new generation of experiments which dwarf earlier rocket and satellite experiments. NASA scientists expect that these experiments will discover hundreds or perhaps thousands of new sources of radiation, and that totally new phenomena and classes of sources will be found. The cosmic radiation also will be measured with unprecedented detail in the hope that its origins may be better understood.

HEAO-1 is rotating slowly end-over-end, with one revolution about every 30 minutes. It uses a gas thrust reaction control system to maintain proper sky scanning orientation so that the solar arrays face the Sun at all times to provide electrical power for the satellite.

HEAO-1 will have a mission lifetime of six months, which is the time required to fully map the celestial sphere.

Many NASA Employees Buy Savings Bonds

Six NASA installations attained a participation rate of 75 percent or higher during the 1977 savings bond campaign, entitling them to special awards in recognition of their achievements. The centers receiving awards were:

Kennedy Space Center—2,239 employees, 92.3 percent participation.

National Space Technology Laboratories, 69 employees, 90.8 percent participation.

Langley Research Center, 3,157 employees, 87.9 percent participation.

Johnson Space Center, 3,586 employees, 78.4 percent participation.

Ames Research Center, 1,612 employees, 77.7 percent participation.

Wallops Flight Center, 435 employees, 91 percent participation.

In Memory of a Lost Son

Off and on, ordinary citizens voluntarily contribute funds to NASA for use in space programs. One man who has been outstanding in regularly sending small sums of money for space research is Coley W. Jay, Chief Petty Officer, USN (ret.), whose contributions now amount to $220. He began donating $20 checks in memory of his 19-year-old son, Phillip Arlen Jay (killed in Navy service in the Far East), following Apollo missions 11 through 17, and Skylabs 1, 2 and 3. Chief Jay's latest contribution arrived immediately after Space Shuttle's *Enterprise* landed safely after separation from its mother ship on Aug. 12. In addition to his $20 check, Chief Jay sent four religious crosses and cards for the Space Shuttle pilots. Expressing great pride in the U.S. space effort and high hopes for the future, he said in an accompanying letter: "Today I feel ten feet tall. Why? Because I witnessed that great first, the Space Shuttle Enterprise successfully make its mark in American history."

Lewis Center Director Retires

Dr. Bruce T. Lundin, for eight years director of NASA's Lewis Research Center, retired on Aug. 26, after 34 years of service with NASA and its predecessor organization NACA. His future plans are not known.

Dr. Bernard Lubarsky, deputy director of Lewis, is acting director until a successor to Lundin has been chosen.

When Lundin joined the staff at Lewis center in 1943, he was engaged in heat transfer investigations and in improving the performance of World War II aircraft engines. In 1946, he became chief of the jet propulsion research section which conducted some of this country's early research on turbojet engines.

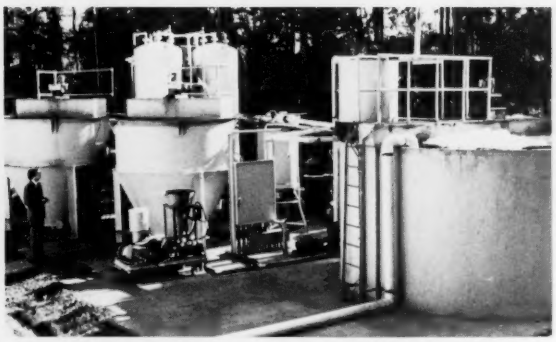
When NACA became the nucleus of the present National Aeronautics and Space Administration in October 1958, Lundin became an assistant director of Lewis, a position from which he directed much of the center's expanded activities in space propulsion and power generation.

In December 1961, Lundin was appointed associate director for development and given responsibility for development of turbojet engines, chemical rockets, electric thrusters for spacecraft propulsion

and electric power generating systems for spacecraft using chemical, solar and nuclear energy sources. He also directed the development and operation of NASA's Centaur and Agena launch vehicles for unmanned spacecraft and of spacecraft for investigating advanced methods of space propulsion.

He became director of the Lewis center in 1969. During his tenure, the center's activities were redirected into research vital to solutions to ever more serious energy problems in the United States.

Lundin is a member of Tau Beta Pi and Sigma Xi, a Fellow of the American Institute of Aeronautics and Astronautics, and the Royal Aeronautical Society. He also is a member of several governmental advisory committees, including the Scientific Advisory Board of the U.S. Air Force, and a former member of the NASA Aerospace Safety Advisory Panel. In 1965 he received the NASA Medal for Outstanding Leadership, in March 1971 the NASA Public Service Award and NASA's highest award, the Distinguished Service Medal, in October 1971.



Waste Treatment Facility—This packaged waste treatment system was built by the General Electric Co. based on technology developed from the biosatellite program. Capable of handling 13,200 liters of waste water a day, the system uses physical and chemical processes to clear waste water, settle the solid matter and remove harmful microorganisms. The solid residue is reduced to a small amount of ash by the plant. Intended experimental unit is presently operational at a Jacksonville, Fla., apartment complex.

Russian Biology Satellite Carries U.S. Experiments

Seven American biological experiments have been successfully launched into orbit aboard the Russian Cosmos 936 satellite. The Soviet biology satellite, launched Aug. 3 from the Plesetsk Base in the Soviet Union, returned its biology payload to Earth in Siberia by parachute in late August, some 22 days after launch.

Cosmos 939 also carried biology experiments and scientific apparatus from Czechoslovakia and France, as well from the Soviet Union. In addition, investigators from Bulgaria, Hungary, East Germany, Poland and Romania took part in the processing of biological specimens and post-flight data and analysis.

The U.S. portion of the mission is managed by NASA's Ames Research Center, whose principal objective is to determine the effects of spaceflight on the physiology, biochemistry, genetics, longevity and morphology of selected biological specimens including rats and fruit flies. The findings will be applied to the problems of ensuring the health, safety and effective performance of people in space.

U.S. scientists traveled to Moscow for payload recovery at the end of August. At the Institute for Biomedical Problems, they participated in the initial processing of experimental materials which then were transported back to the U.S. for further study. The U.S. scientists participating in the Cosmos 936 mission are:

Drs. Jaime Miguel and D. E. Philpott of the Ames center: Effects of weightlessness on the genetics and aging process of fruit flies.

Drs. H. A. Leon of Ames and S. A. Landaw, Veterans Administration Hospital, Syracuse, N. Y.: Effects of weightlessness and centrigufation on random hemolysis and lifespan of red blood cells during space flight.

Drs. Samuel Abraham and Chui Lin of Childrens Hospital Medical Center, Oakland, Calif., and Dr. H. P. Klien and C. M. Volkman of Ames: Analysis of liver tissue for enzymes involved in the conversion of carbohydrates to lipids.

Drs. E. M. Holton of Ames and D. J. Baylink of the V. A. Hospital, Seattle, Wash.: Quantitative analysis of selected bone parameters.

Drs. E. V. Benton, R. P. Henke, D. D. Peterson, Allan Frank and Ronald Cassou of the University of San Francisco: Radiation dosimetry experiment.

Drs. D. E. Philpott and Gladys Harrison of the Ames center: Histologic and ultrastructural examination of eye tissue.

Drs. J. P. Van Der Meulen, L. A. Chui and Joan Higgins of the U.S.C. Medical Center and K. R. Castleman of NASA's Jet Propulsion Laboratory: Muscle fiber analysis of cosmos rats.

Kenneth A. Souza of Ames is the project manager for the U.S. experiments, and Richard M. Farrell of NASA headquarters is the manager of the Joint USSR-U.S. Biological Satellite Program.

Five of the seven U.S. experiments are extensions of experiments flown on the first cooperative USSR-U.S. biological satellite, Cosmos 782, launched in November 1975. Four of the U.S. experiments have Soviet coinvestigators and all receive to varying degrees Soviet scientific and technical assistance.

Without the Soviet flight opportunity, U.S. biological spaceflight experiments would have to wait for flight of the Space Shuttle in the 1980s. The last U.S. biological research spacecraft launched was Biosatellite 3 in 1969.

Conferences Cross-Country via Satellite

NASA's Goddard Space Flight Center, working with the National Commission on Cooperative Arrangements, Washington, D.C., again demonstrated the feasibility of satellite teleconferencing via the communications technology satellite recently when a three-hour televised conference united Goddard and NASA's Ames Research Center.

The conference was held to give individuals from government, public broadcasting organizations, research centers and community leaders, (community college chief officers) an opportunity to use this new technology and to discuss communications options under congressional and public organization consideration.

One of the main subjects of the conference was to investigate the possibility for greater grass-roots advice and broadbased public participation in reviews and revisions of national communications policy.

A later conference on telecommunications to be held Nov. 20 to 23 in Kansas City, will be entitled "The Community and Telecommunications."

The teleconference was chaired by Albert Kramer, director, office of consumer affairs, Federal Trade Commission, and a former public interest lawyer in communications.

Section chairman of the recent conference was Norman Watson, chancellor, Coast Community College District, (Calif.) and Jay Carsey, president, Charles County Community College (Md.) representing the west and east coasts.

A video tape of the conference was made for later use by the Southern Education Communications Association which includes 98 public broadcast stations in 16 states. In addition, the tape will be made available to other public broadcast stations in other parts of the country.

Expanding the Range of Planetary Sightings—These two photographs illustrate the dramatic progress made in five years in the ability of NASA satellites to record features of distant planets. The first photo of the giant Martian volcano called Olympus Mons—a mountain 600 km across at its base, or nearly three times as broad as Earth's most massive volcanic pile (Hawaii) was made by Mariner 9 in 1972. The second photo of part of the caldera (volcanic crater) at the summit of Olympus Mons was taken by Viking orbiter 1 in 1977 (in mosaic form), showing the 27.4-km high mountain in vivid detail, down to craters only 18 m across. The deepest crater (top center) is about 25 km across.

Interviews Begin for Shuttle Astronaut Applicants

The first 20 of approximately 200 Space Shuttle astronaut applicants to be selected for individual interviews and physical examinations reported to NASA's Johnson Space Center in early August.

The second group of 20 reported to JSC in mid-August. A third group of 20 Space Shuttle astronaut applicants selected for individual interviews and physical examinations, all in the mission specialist category, reported to NASA's Johnson Space Center on Aug. 29, to remain there for one week.

NASA expects the applicants to be interviewed at the Johnson center to be about evenly divided between pilot and mission specialist applicants. All in the first two groups are pilot applicants.

Eight of the 20 potential astronauts are women. All 20 in the third group either have Ph.D. or medical degrees or both and one also has a degree in veterinary medicine.

"We are pleased with the quality of applicants," Johnson center director Christopher C. Kraft, Jr., said. "It is difficult to narrow the field for interviews and paring that number will be a real challenge."

Each group of applicants—which will include 200 of the 8,079 applicants—will spend about one week at the Johnson center. Officials expect to complete the process by mid-November. In December, NASA will select as many as 20 astronaut candidates in each of the two categories—pilot and mission specialist. The candidates will report to the Johnson center in mid-1978 for two years of training and evaluation. Final selection as an astronaut will depend on satisfactory completion of the evaluation period.

Italian Communications Satellite Launched

The first Italian experimental communications satellite, SIRIO, was launched Aug. 17 from NASA's Kennedy Space Center on a Delta vehicle.

The satellite was placed in synchronous orbit over the west coast of Africa at 15 degrees W. longitude. From this position it will be able to carry out various scientific experiments in the telecommunications field.

The principal experiment is designed for study of the propagation characteristics of radio waves transmitted at super high frequencies during adverse weather conditions including rain, snow and fog.

A whole segment of Italian industry interested in space technology worked on the spacecraft and is expected to use the acquired experience in future international space programs. The name SIRIO (Italian for Sirius, the dog star) also is an acronym for industrial research-oriented Italian satellite—*Satellite Italiano Ricerca Industriale Orientata.*

From its initial on-station position, SIRIO will transmit voice, data and television in the SHF (super high frequency) range from Europe to North America. The use of the SHF frequencies is becoming necessary because of overcrowding of lower conventional frequency bands.

SIRIO is 1.4 meters in diameter, 2 m high, including the apogee boost motor, which is included in the satellite's weight of 398 kilograms.

The Italian government research agency, *Consiglio Nazionale della Ricerche*, is sponsoring the project with coordination of the experiments under the direction of the *Centro Studi Telecommunicazioni Spaziali del Politecnico* at Milan. A memorandum of understanding dated March 13, 1970, governs the portions of the project which are the responsibility of the Italian government and those of NASA, primarily launch support services for 30 to 45 days after launch. These include the Delta 2313 launch vehicle, launch from ETR and significant post-launch tracking and data acquisition support. The expendable launch vehicle program office in the Office of Space Flight at NASA headquarters manages the Italian contract. Overall responsibility for the satellite passed to Italy as soon as the spacecraft was separated from the launch vehicle although an Italian and American mission control center team at NASA's Goddard Space Flight Center actually handled operations until SIRIO was checked out.

The Goddard center directs the Delta project and McDonnell Douglas Astronautics Co. of Huntington Beach, Calif., is the prime contractor. The Kennedy center was responsible to the Goddard center for management of launch operations.

Gamma-Ray Study at MSFC

A group of scientists at the Marshall center are studying data collected on a gamma-ray detector payload carried aloft May 11 on a balloon flight. Members of the National Scientific Balloon Facility successfully launched the payload on a balloon flight from Palestine, Texas.

The payload, consisting of an array of 12 large-area, gamma-ray detectors, was developed and constructed by Marshall center astrophysicists as part of a study in high-energy astronomy. The array and a telemetry system were used to observe and

monitor bursting and pulsating X-ray and gamma-ray sources during an 18-hour balloon flight.

A 420,000-cubic-meter capacity balloon lifted the 590-kg payload to a float altitude of 39 km, while a telemetry system transmitted data to the Palestine receiving site for monitoring and recording.

The mission was successful, but high winds caused the group to shorten the proposed 40-hour float and forced the craft to land near near Fort Stockton, Texas, 965 km from the launch site. Some damage to the investigative payload occurred during the landing in high surface winds.

A preliminary review of the collected data conducted by Marshall scientists and principal investigator Dr. Charles Meegan (a National Research Council Research Associate) indicate successful observations of the galactic center region and Cygnus X-1, an X-ray source, as well as new evidence about atmospheric X- and gamma-radiation.

The group of investigators plan to use the collected data in conjunction with results from NASA's High Energy Astronomy Observatory program.

Career Exploration Program in Sixth Year at Langley

Taking part in a four-week career program sponsored recently by the educational programs office at NASA's Langley Research Center were 21 high-school students from nearby Virginia regions.

The program, which began in 1972, provides students the opportunity to work with a NASA sponsor in an area related to the student's potential career interest field. After an intensive selection process, students are assigned to a sponsor in science, computers, engineering, or mathematics—depending on his or her interest. Throughout the program, students are exposed to various scientific and technical work environments which helps to familiarize them with various career fields, and to see how research techniques and scientific concepts studied in the classroom are applied in real work situations.

Potential Space Proponents—During Langley's "career day," high-school students view space exhibits and are given opportunities to interact with representatives from professional societies, industry, academic institutions and government agencies.

Career Exploration Program Candidate—A Virginia high-school student becoming acquainted with the complexities of space-related research at the Langley center.

A cross sectional view of the wide range of research being conducted at the center was incorporated into the 1977 experience. Students assisted professionals and technicians in the areas of computer science, wind tunnel research, rotary wing research, energy efficient research, noise reduction research, and many other research areas. They worked on an eight-hour day routine, with no monetary reward.

Donald P. Hearth, director of the Langley center, awarded each of the students a "Certificate of Outstanding Achievement" during a ceremony at the conclusion of the four-week program. He termed the program a success thanks to the excellent efforts and achievements by the students and the cooperation and contributions of LRC personnel.

Gillam Promoted at Dryden Center

Isaac T. Gillam IV, formerly director of space shuttle operations at NASA's Dryden Flight Research Center, became deputy director of the center in August. He succeeds Gerald D. Griffin who is now deputy director of the Kennedy Space Center.

Dryden is NASA's prime center for aeronautical flight research and conducts programs over the entire

flight regime in support of national civil and military needs. The Space Shuttle orbiter, central element in the nation's new Space Transportation System, is undergoing its initial atmospheric flight tests this year at the center. Gillam has been responsible for the Dryden activities in support of the Shuttle tests there. In 1979, Dryden will be the site of orbiter landing and recovery during the first few orbital flight tests.

Before reporting to Dryden in May 1976, Gillam for three years was manager of small launch vehicles at NASA headquarters. He came to NASA headquarters in 1963 as a resources management specialist. In February 1966, he was appointed assistant Delta program manager in the launch vehicles directorate and in September 1968, he was named Delta program manager.

Before his NASA assignment, Gillam served in the U.S. Air Force from 1953 to 1963 as a pilot, missile launch crew commander and ROTC instructor.

A native of Little Rock, Ark., Gillam was graduated from Howard University with a bachelor of arts degree in 1952 and did graduate work at Tennessee State University, Nashville, while assigned as assistant professor of air science.

Gillam received the NASA Distinguished Service Medal, among other awards, for his activities in the launch vehicle program.

Helicopter Structures Technology Conference

The rapidly advancing area of structures technology will be the subject of a special conference slated for Nov. 16-18. The conference recently was announced by its co-sponsors, the Western Region of the American Helicopter Society and NASA's Ames Research Center. Specialists in rotorcraft structures from throughout the free world will convene at Ames (Moffett Field, Calif.) to review advances in materials and structures, to discuss research goals for further development, and to identify current or future programs that could benefit from the application of advanced structures technology.

The program will include three general sessions and two panel discussions. Chairmen for each of the sessions are now making final arrangements and selection of participants for each portion of the program. The conference general chairman is Andrew W. Kerr, aerospace engineer, U.S. Army Air Mobility Research and Development Laboratory, Moffett Field, Calif. and vice president, AHS western region. The technical chairman for the meeting is Frederick H. Immen, chief, advanced systems research office, U.S. Army Air Mobility R & D Laboratory. In charge of arrangements is James Biggers of the Ames center.

In announcing the meeting, chairman Fred Immen said, "Advances in structures technology have been remarkably impressive. The potential for further developments and for intensive application of present technology are extremely bright. This conference will provide the year's best opportunity to review this field and the proceedings report, which will be a NASA technical memorandum, will surely be an important reference for years to come."

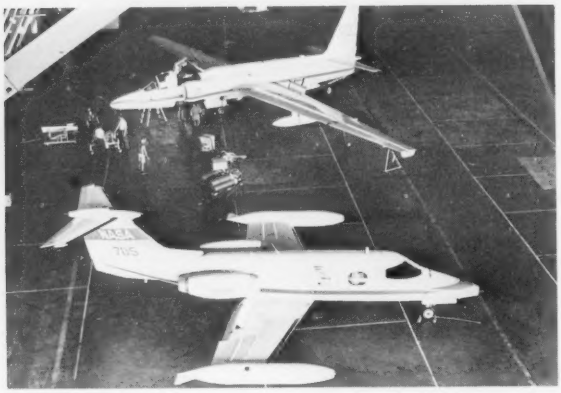
For further information, contact Richard S. Dunn, HQ Army Air Mobility R & D Laboratory, Moffett Field, Calif., Comm: 415-965-5578; AUTOVON: 586-5655.

Space Applications Chief Leaves NASA

Bradford Johnston, Associate Administrator for Applications resigned as of Sept. 30. NASA administrator Dr. Robert Frosch commended Johnston's work at NASA, saying: "During his tenure he has worked to further the agency's goal of identifying and demonstrating the useful applications of space techniques. His contributions have enabled NASA to make significant progress in its applications program, reshaping it to be more responsive to national needs."

Johnston joined NASA as Associate Administrator for Applications June 7, 1976, after the retirement of Charles W. Mathews.

A Hundredth Anniversary—Marking the 100th anniversary of the discovery of Martian moons Phobos and Deimos, A. Thomas Young (right) director of NASA's Planetary Programs Division in Washington, D.C., presents a closeup photograph of Phobos taken by the Viking cameras at Mars to Capt. Joseph C. Smith of the U.S. Naval Observatory.



Research Planes in Panama—Two NASA research aircraft were based in Panama this summer for intensive studies of atmospheric pollution. The aircraft, a Lear Jet (foreground) and a Lockheed U-2, are both operated by NASA's Ames Research Center. In first photo, they are shown in a hangar at Howard Air Force Base, Panama Canal Zone. The two airplanes, heavily instrumented with sensing and sampling equipment, made daily flights to measure atmospheric pollutants at altitudes of up to 21.3 km over a 16-day period. In the second photo, a NASA U-2 Research Aircraft takes off from Howard Air Force Base, Panama Canal Zone, for an atmospheric sampling mission.

NASA Patents Possible Aid to Cancer Therapy

NASA has received a patent on a process for control of cell division that the inventor says may establish new approaches for the treatment of cancer and may affect replacement of lost nerve cells in the brain and other parts of the human nervous system.

(*continued on page 19*)

Potent Chasers—The five T-38 jet aircraft used as "chase" planes on Space Shuttle carrier and orbiter flights at the Dryden center (Edwards Air Force Base, Calif.) surround the mothership Boeing 747 after the *Enterprise* has landed on the dry lakebed runway. The occasion was the second separation of the two craft, which took place Sept. 13. The chase planes operate as observers, monitors and reporters to ground control units. They are in constant communication with both Space Shuttle pilots and mission controllers and keep a photographic record of the flights.

The patent covers processes developed by Dr. Clarence D. Cone, Jr., chief of the cell and molecular biology laboratory at the Veterans Administration Hospital Center at Hampton, Va. Cone began his work on the project at the molecular biophysics laboratory at NASA's Langley Research Center in Hampton, in a study concerning the effects of space radiation on living cells. He moved to the V.A. center in 1975.

Cone notes that his research has resulted in basic new understandings of why cells reproduce or don't reproduce and implies that, if the ionic levels in cells in the human body can be manipulated, it might be possible to reverse or inhibit the uncontrolled proliferation of cancer cells, a characteristic of the disease.

Cone points out that many agents have been found that will either block or stimulate cell division but most will not both block and stimulate cell division. His method, Cone says, can turn cell division either on or off. Its action is relatively natural inasmuch as it is patterned after normal ionic mechanisms apparently used by the body to influence cell division control.

"The process thus opens up an entirely new direction of therapeutical research possibilities for cancer treatment and, among many other medical application possibilities, offers promise of eventually effecting neural replacement in the human brain and body," Cone said. "Initial application of the process to induce cell divisions in spinal cord neurons in cultures have been excitingly successful."

Cone's process involves changing relative concentrations of positive sodium and potassium ions and negative chloride ions in the cells so that the electrical potential difference across the cell membranes is changed. Cone found that conditions corresponding to differences of from minus 70 to minus 90 millivolts in a cell will block cell division while those with smaller potential differences of from minus 10 to minus 20 millivolts will stimulate active proliferation.

"There are many ways in which these electrical changes can be produced in cells," Cone said. "One method is to surround the cell or cells with a solution equivalent to that normally surrounding the cell except that the relative concentrations of sodium, potassium and chloride ions are changed."

Cone conducted his initial experiments and demonstrations of the process in his NASA laboratory using rodent cells in cultures. He was able to measure the changes in voltage accurately by inserting microelectrodes into the cells.

The patent cites several examples in which Cone was successful in stimulating the cells to divide and proliferate and in blocking cells from dividing and proliferating. In these cases the cells were not damaged and the processes demonstrated were reversible.

Also, he says, the new procedure might eventually be able to induce mature nerve cells to divide and bring about cell replacement in the human brain and nervous system, a development that could be helpful in allaying senility or in treating brain and spinal cord injuries.

Cone's original degree is in chemical engineering. He also holds a master's degree in aeronautical engineering and a doctor of philosophy degree in biophysics and cell biology.

Prolonged Performance by Laser Achieved Under NASA-University Experiment

Under a grant from NASA, University of Florida (Gainesville) researchers have successfully demonstrated continuous operation of a nuclear-pumped gas laser for the first time. Earlier nuclear-pumped lasers were able to produce only short bursts of energy.

A laser beam is a highly efficient conductor of energy. In space operations, the continuous laser operation developed by university researchers would be able to deliver large amounts of energy between sources and users over long distances.

Most gas lasers are energized or "pumped" with electricity generated by burning coal or oil or from nuclear reactors, a process that causes the loss of considerable energy. The nuclear-pumped laser converts energy directly from nuclear reactions, without the losses caused by having to first convert heat into electricity.

University of Florida researchers described the complex procedure by explaining that first of all they used the research reactor at the Georgia Institute of Technology, placing a stainless steel tube containing helium and neon beside the reactor core. Reactor-produced neutrons entered the tube, splitting helium-3 isotopes present in the tube into high energy triton and proton particles. Collisions of these particles with the neon atoms produced continuous lasing, as demonstrated by the eight-fold amplification of a low power laser beam aimed through the tube.

A repetition of the research reactor at the University of Florida confirmed the results. The

duration of the lasing (transmission of energy) was about 15 minutes, but it could have lasted for a much longer period.

Under a grant from the research division of NASA's Office of Aeronautics and Space Technology, students B. Dudley Carter and Michael J. Roe, under the leadership of Prof. Richard Schneider are given credit for the important development.

EEO Specialist's Contribution Recognized—James T. Dixon, equal opportunity specialist in the Office of Equal Opportunity Programs, was honored recently at the Eighth Annual Seminar of the National Urban League's Black Executive Exchange Program (at Atlanta, Ga.) for his service during the past academic year as visiting professor teaching human relations courses at Philander-Smith College in Little Rock, Ark. The Black Executive Exchange Program provides top black professionals and executives to the traditionally black colleges to serve as visiting professors. The program was initiated by the Urban League in 1969 to offer black college students an insight into the practical applications of classroom theory as utilized in the world of business and industry. The executives also provide students with advice on breaking into and moving ahead in their careers.

Secretary Chosen as MIT Fellow—Mrs. Diane A. Moore, 35, secretary to the NASA headquarters Equal Employment Opportunity Officer, is among 10 individuals selected from across the country to participate in the Massachusetts Institute of Technology's Community Fellows Program in the Department of Urban Planning and Studies. She is the first non-professional NASA employee to earn the distinction. Moore has been employed as a secretary at NASA headquarters since January 1969. She reported to MIT on Aug. 10 to conduct research for minorities and females employed at NASA headquarters. She also will study statistics and psychology, and undertake pre-law courses during her one-year fellowship at MIT to prepare for a career in law. Moore is a native of Huntington, W. Va.

Former NASA Center Director Appointed Air Force Under Secretary

Dr. Hans M. Mark, former director of NASA's Ames Research Center was sworn in Aug. 9 as Under Secretary of the Air Force by Secretary of Defense Harold Brown in Washington, D.C. Mark's wife, his father, Prof. Herman Mark of Polytechnic Institute, Brooklyn, N.Y., his brother, Prof. Peter Mark of Princeton University and other friends and associates attended the ceremony.

Hans Mark was director of the Ames center for eight years, from February 1969 until July 1977. His research appointments include Massachusetts Institute of Technology, the University of California at Berkeley, and the Lawrence Radiation Laboratory at Livermore, Calif.

Mark served as associate professor of nuclear engineering at the University of California at Berkeley, as a consulting professor of engineering at Stanford University, and has taught undergraduate and graduate courses in physics and engineering at Boston University and the Massachusetts Institute of Technology.

Dr. Mark is a member of the National Academy of Sciences Committee on Atomic and Molecular Physics. He is a fellow of the American Physical Society, and the American Institute of Aeronautics and Astronautics. He is also a member of Sigma Xi and Phi Beta Kappa. He has for many years been a consultant with the Institute for Defense Analyses, the USAF Scientific Advisory Board, and a number of other scientific and defense-related agencies.

He is co-editor of the book, "The Properties of Matter under Unusual Conditions," and co-author of a textbook called "Experiments in Modern Physics."

Dr. Mark was born in Mannheim, Germany, June 19, 1929. He came to the United States in 1940 and became a U.S. citizen in 1945.

Florida Family Moves into Unique NASA "Tech House"

The Charles Willam Swain four-member family became active participants in an unusual NASA research project that began in mid-August when the Swains moved into the technology utilization house at NASA's Langley Research Center to begin a one-year residency. They were welcomed to the city of Hampton by Mayor Ann H. Kilgore, and presented with the keys to their three-bedroom house by Langley director Donald P. Hearth.

During their stay in Hampton, the Swains will use and help evaluate various systems in and around the house that are designed to save energy and water, and make the home more secure.

Preliminary estimates are that the technical systems, all of which are available to the general consumer now or will be within the next five years, can result in a saving of a third of the energy used in a building of comparable size and style, and use only half as much water as that consumed by conventional systems.

The Swains come from Tallahassee, Fla. Dr. Swain is a professor at Florida State University in Tallahassee. His academic background is in the humanities, with an interest in career counseling. He will work with Langley's personnel division in a one-year educational exchange program to provide advice on employee relations. His wife is a registered nurse who hopes to continue her career while living at Langley.

(*continued on page 22*)

Recognition for Former Langley Director—Langley research Center Director Donald P. Hearth recently presented the NASA Distinguished Service Medal to Edgar M. Cortright, who was Langley's director from 1968 to 1975. The medal was presented "in recognition of his distinguished leadership while director of the Langley Research Center from the concept of the Viking Project in 1968, through its design and development, to the launching of its two spacecraft in the summer of 1975, he guided and inspired the Viking team toward an unprecedented success in the exploration of Mars."

She is former associate head nurse of the Tallahassee hospital and a member of that city's volunteer health clinic. Their two children, Carol, 17, and Charles, 12, will attend Hampton schools.

The Swains were selected as tenants from a list of seven families provided to Langley management by the Washington, D.C.-based American Council on Education, a non-profit organization that sponsors university professors for work with the Federal government.

The Swains will pay a prorated rent during their year-long "lease" of the Tech House, as well as all utility charges. Like many American families, the Swains will be unable to park the family car in the Tech House garage, because it is packed with the technical monitoring equipment that controls and measures the house energy- and water-saving systems.

NASA Employee Joins New District University

Leon N. Perry, former public information officer for minority affairs at NASA headquarters, has been selected to assist in developing the Institute in Community and Public Services at the newly created University of the District of Columbia. His assignment is for one year.

The 40-year old veteran information officer has been detailed to the project under terms of the Intergovernmental Personnel Act. NASA will be responsible for his salary and fringe benefits. He will serve as a special assistant for information systems to Ronald C. Johnson, director of the institute.

The Institute in Community and Public Services is a new concept in the university, providing assistance to local government and its citizens. It will seek to bridge the gap between the District government and the citizens of the nation's capital. It will also function as a vehicle for greater citizen access to government, and as a "think-tank" for elected and appointed officials on issues of housing, energy, transportation, human resources, and other community matters.

Perry has been with NASA's office of public affairs since January 1974. He was previously the director of public information for the governor's office of human resources in Illinois. He also has been employed as director of news and community relations with radio stations WVOL in Nashville and KATZ in St. Louis.

Active in civic and community activities, Perry is a volunteer public relations assistant for the NAACP and also is a commissioner of human relations for Prince George's County, Md. where he resides.

Institute director Johnson says Perry is the first of several professionals he expects to recruit to the institute staff through provisions of the IPA to help create the needed capability to make the project a success. Johnson himself is on loan to the Institute project from the U.S. Department of Housing and Urban Development.

New NASA Publications

NASA Films, July 1977 is available agencywide from the NASA public information office. The 32-page brochure lists films of general and special interest as well as many designed for classroom use. Filmstrips and audiotapes also are listed. The brochure explains how to go about purchasing or borrowing the 104 available NASA films. Address requests to Mail Code F, NASA headquarters.

Space Shuttle, NF-79 is a new eight-page NASA Facts publication for sale by the U.S. Government Printing Office at 60 cents per copy. The heavily illustrated publication explains the basic features and philosophy of the Space Shuttle.

Skylab Explores the Earth (NASA SP-380)—As one in the series of formal NASA Special Publications resulting from the highly successful Skylab project, "Skylab Explores the Earth" is unique in that it shows through the eyes of the Skylab 4 cameras the massive climatic systems that govern the Earth from season to season. The cameras were trained—and scientific analyses completed—on such natural phenomena as mesoscale cloud features, desert sand seas, floating ice (from the St. Lawrence River to the South Pacific), global tectonics, and vegetation patterns—to mention some of the observations. Clothbound. 536 pp. For sale by Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $17.50.

Pioneer Odyssey (NASA SP-349)—This summary volume describes the flights and the scientific results of the Pioneer spacecraft. It includes four-color images of Jupiter obtained by Pioneers 10 and 11. Clothbound. 236 pp. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $9.85.

Launches for 1977—Completed and Projected

Name	Launch Date	Vehicle	Range	Mission Remarks
NATO-3 B	Jan. 27	Delta	ETR	Second communications satellite in synchronous orbit to perform communications relay for NATO. Reimbursable.
Palapa-2	March 10	Delta	ETR	Back-up satellite for Indonesian domestic communications network. Reimbursable.
GEOS/ESA	April 20	Delta	ETR	ESA spacecraft to conduct scientific investigation of waves and particles in magnetosphere. Reimbursable. Failed to reach correct orbit.
Intelsat IVA-C	May 26	Atlas/Cen.	ETR	Improved communications satellite for Comsat. Reimbursable.
GOES/NOAA	June 16	Delta	ETR	Second operational satellite to provide continuous daytime and nighttime global cloud cover observations for NOAA. Reimbursable.
GMS-Japan	July 14	Delta	ETR	Geosynchronous Meteorological Satellite. Japanese portion of global network of geostationary environmental satellites. Reimbursable.
HEAO-A	Aug. 12	Atlas/Cen.	ETR	High Energy Astronomical Observatory to study energetic radiation from space.
SIRIO-I	Aug. 17	Delta	ETR	Italian project to investigate radio propagation, trapped radiation flux, magnetic field intensity and variation, and the primary electron energy spectrum. Reimbursable.
Voyager 2	Aug. 20	Titan III Centaur	ETR	Jupiter and Saturn planetary systems and the interplanetary medium out to Saturn.
Voyager 1	Sept. 5	Titan III Centaur	ETR	Same as above.
OTS/ESA	Sept. 9	Delta	ETR	Orbital Test Satellite. ESA experimental communications satellite. Reimbursable. Launch vehicle exploded. Investigation underway.
Navy Transit	Sept. 28	Scout	WTR	Navy navigation satellite. Reimbursable.
Intelsat IVA-D	Sept. 29	Atlas/Cen.	ETR	Follow-on series of improved communications satellites for Comsat. Launch vehicle exploded.
ISEE-A/B	Oct. 13	Delta	ETR	NASA's international Sun-Earth explorer.
FLTSATCOM	Nov.	Atlas/Cen.	ETR	DOD fleet communications satellite.
Meteosat/ESA	Nov. 3	Delta	ETR	ESA meteorological satellite. Reimbursable.
Intelsat IVA-E	Nov. 10	Atlas/Cen.	ETR	Follow-on earlier Intelsats.

Huge Wind Tunnel—Artist's concept (top center) of the Ames center's 12 by 24-meter wind tunnel with the addition of the new test leg that will add a much larger test section to the existing facility. The test leg, which will house a 24 by 36-m test section will be attached to the west wall of the existing structure and will be about 165-m long, 45-m high, and 36-m wide, fanning out to a width of approximately 127 m at the northwest end. The project also provides for repowering of the wind tunnel, which will increase test velocities in the existing 12- by 24-m test section from the present 370 kilometers per hour to 360 km/h. Completion of the project is scheduled for early 1981.

Space Shuttle's First Year to Be a Busy One

NASA has identified some 40 payloads for 11 Space Shuttle flights in its first year of operation beginning in 1980.

Chester M. Lee, NASA's Director of Space Transportation System Operations, said that three civilian firms have deposited "earnest money" with the space agency covering payloads on eight flights. He added that NASA has firm plans for launching five payloads, and the Department of Defense will launch one.

"And there are 12 non-NASA civil payloads, 10 NASA and four Department of Defense payloads forecast for launch during 1980 and 1981," Lee said. "Clearly the pipeline is beginning to fill up."

The Space Shuttle is the key element in NASA's Space Transportation System. It will make its first space test flight in 1979. Six of these orbital flight tests are scheduled before the first operational flight takes place in 1980.

Allocation of payloads to specific flights is still in the early planning stage and will not be firmed up until about one year before launch. Current allocations are as follows:

Space Shuttle Flight 7 (Flights 1 through 6 are test flights)—Long duration exposure facility (LDEF), is a passive, free-flying satellite that will accommodate a large number of experiments to be conducted in space and in an experiment pallet.

Space Shuttle Flight 8—Tracking and Data Relay (TDRSS-A), for Western Union and a communications satellite for Satellite Business Systems (SBS-A).

Space Shuttle Flight 9—A geostationary operational environmental satellite for the National Oceanic and Atmospheric Administration (Commerce Dept.) and Telesat-E, a communications satellite for Canada.

Space Shuttle Flight 10—TDRSS-B for Western Union and SBS-B for Satellite Business Systems.

Space Shuttle Flight 11—Spacelab 1. Spacelab is being built by the European Space Agency. This first Spacelab mission is a joint NASA/ESA science mission.

Space Shuttle Flight 12—GOES-E for NOAA and Intelsat 5 for the Communications Satellite Corp.

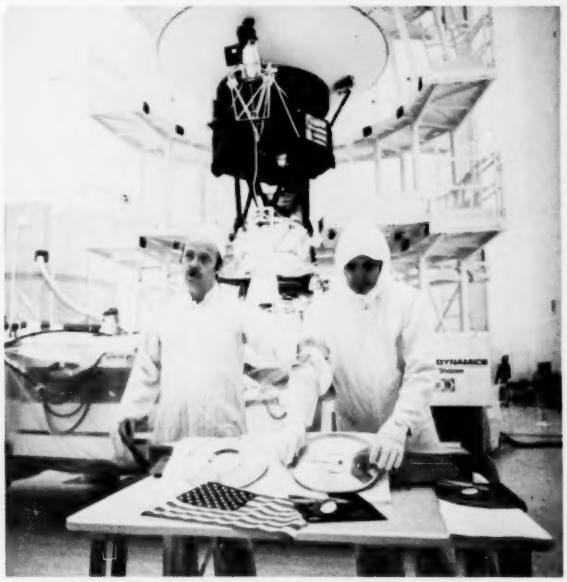
Prospectus

"Sounds of Earth"

As we know, one of our major goals in space is the scientific exploration of the solar system and the universe. The two Vikings still sending their invaluable data back from Mars, and the two Pioneers flying through deep space outside the orbit of Jupiter enroute to Saturn and beyond are dramatic elements of a carefully phased program of reconnaissance, exploration and intensive study by which we are pursuing that goal. Now Voyagers 1 and 2 have joined the array of spacecraft enroute to deep space. And they are only the latest in a 14-year series of automatic, remote controlled explorers which have been dispatched millions of miles into the previously unknown to report on the characteristics of our sister planets and the great void of space between.

One of the most intriguing and potentially significant aspects of this program is the search for other intelligent life.

We would all like to feel that we are not alone in the universe. It would be somehow deeply



A Future "Golden Oldie"—The "Sounds of Earth" record as it was affixed to a Voyager spacecraft. The copper record is encased in a gold-plated aluminum shield to protect it during flight past Jupiter and Saturn, and out of the solar system. Its sounds may be heard eons hence by extraterrestrial beings light years away from Earth.

reassuring to learn that elsewhere than on this particular planet, matter and energy have combined to form the self-replicating cells we know as life.

And there is good reason to believe that such is the case.

We know from radio astronomy measurements that organic molecules essential to our type of life are plentiful throughout the universe.

We know that possibly 20 billion stars of the 125 billion or so in our own galaxy have the right temperatures and luminosities to support planets on which life could develop.

Those are pretty good odds. If we assume that intelligent life does not have a built-in tendency to self-destruct, either by blowing itself up, exhausting its resources or destroying its ecology, there could be a billion other worlds out there where life exists, has existed or will exist.

Given those favorable odds, Pioneers 10 and 11, which will become the first man-made objects to leave the solar system, carry gold plates which tell in "scientificese" of humans, where and when the species lived and the biological form of Earth's inhabitants. The plates were designed by Wendy Sagan in consultation with her husband, Carl Sagan, and the distinguished cosmologist A.G.W. Cameron.

Somewhere between one and ten billion years from now one or both Pioneers may pass through the planetary system of a remote stellar neighbor, one of whose planets may have evolved intelligent life.

If that life possesses sufficient intelligence to detect the Pioneer it may also have the curiosity and the technical ability to pick up the spacecraft and take it into a laboratory to inspect it. We can hope that the plaque with its message from Earth people will be found and deciphered.

The two Voyager spacecraft, launched on Aug. 20 and Sept. 5 of this year, on missions to Jupiter, Saturn, their satellites and the outer planets, will carry similar plaques, but will go the Pioneers one better.

The 12-inch discs contain greetings from Earth people in 60 languages, samples of music from different cultures and eras, and natural sounds of surf, wind and thunder, birds, whales and other animals. The records also contain electronic information that an advanced technological civilization could convert into diagrams, pictures and printed words, including a message from President Carter.

The main Voyager objective is to conduct a detailed scientific investigation of giant Jupiter and ringed Saturn, 11 of their moons and possibly the planet Uranus, before the spacecraft leaves the solar system on a journey without end among the stars.

Each Voyager carries a copper phonograph record and a phonograph head. The records are appropriately labeled "Sounds of Earth," and their contents were assembled by a group of prominent scientists and educators.

The message on the records was designed to enable possible extraterrestrial civilizations that might intercept the spacecraft millions of years in the future to piece together some picture of 20th century Earth and its inhabitants.

"Because space is empty, there is essentially no chance that Voyager will enter the planetary system of another star," said astronomer Carl Sagan of Cornel University. "The spacecraft will be encountered and the record played only if there are advanced spacefaring civilizations in interstellar space. But, as the beautiful messages from President Carter and Secretary-General of the United Nations, Kurt Waldheim indicate, the launching of this 'bottle' into the cosmic ocean says something very hopeful about life on this planet."

The idea for the record was formulated by Sagan and the repertoire was selected by an advisory committee of prominent scientists, musicians and others. Phonograph records were chosen for the Voyagers because they can carry a great amount of information.

Each record is made of copper and is fitted into an aluminum protective jacket. It contains, in scientific language, information on how the record is to be played, using the cartridge and needle provided. The record begins with 115 photographs and diagrams in analog form, depicting mathematics, chemistry, geology, and biology of the Earth, photographs of human beings of many countries, and some hint of the richness of our civilization. Included are schematics about the solar system, its dimensions and location of the Milky Way galaxy, descriptions of DNA and human chromosomes, photographs of Earth, the Voyager launch vehicle, a large radio telescope and human beings in various settings and endeavors.

That information is followed by spoken greetings in some 60 human languages.

Next comes a sound essay on the evolution of the planet Earth, including sounds of weather and surf, the Earth before life, life before humankind

appeared, and finally the development of human civilization.

The musical selections, which run to almost 90 minutes playing time, are representative of the cultural diversity of Earth, of many times and places, and include both Eastern and Western classical music and a variety of ethnic music. Included is music from Senegal, Australia, Peru, Bulgaria, and Azeraijan, as well as jazz and rock-and-roll (Louis Armstrong and Chuck Berry, for example). In the classical repertoire are compositions by Bach, Beethoven, Mozart, and Stravinsky, as well as Javanese Gamelan, Indian Raga, Japanese Skakuhachi, and Chinese Ch'in music. The entire 16⅔-rpm record runs nearly two hours.

Because of the aluminum cover and the emptiness of interstellar space, the record is likely to survive more than a billion years. Thus it represents not only a message into space but also a message into time.

Among the members of Dr. Sagan's committee and others who played a major role in devising the Voyager record are Dr. Frank Drake, Cornell University; Dr. A. G. W. Cameron, Harvard University; Dr. Phillip Morrison, Massachusetts Institute of Technology; Dr. Bernard Oliver, Hewlett-Packard Corporation; Dr. Leslie Orgel, Salk Institute; Mr. Alan Lomax, Choremetrics Project, Columbia University; Dr. Robert Brown, Center for World Music, Berkeley, Calif.; Murry Sidlin, National Symphony Orchestra, Washington, D.C. and artist Jon Lomber, Toronto, Canada. The record was produced by Timothy Ferris; the creative directive director was Ann Druyan, both of New York City.

The record was prepared for NASA as a public service by Columbia Records. Permission to use copyrighted material on the record has been given to NASA by the owners, also as a public service.

The Voyagers, if on schedule, should arrive at Jupiter in 1979, Saturn and its rings in 1980, and possibly examine Uranus in 1986. The two spacecraft will be considered to have left the solar system when they cross the orbit of Pluto in 1989.

Additional information concerning the full contents of the Voyager records may be obtained from NASA's newsroom, Code FP, Washington, D.C. 20546. Refer to release 77-159.

President Carter's statement is printed in its entirety in the following reproduction.

This Voyager spacecraft was constructed by the United States of America. We are a community of 240 million human beings among the more than 4 billion who inhabit the planet Earth. We human beings are still divided into nation states, but these states are rapidly becoming a single global civilization.

We cast this message into the cosmos. It is likely to survive a billion years into our future, when our civilization is profoundly altered and the surface of the Earth may be vastly changed. Of the 200 billion stars in the Milky Way galaxy, some -- perhaps many -- may have inhabited planets and spacefaring civilizations. If one such civilization intercepts Voyager and can understand these recorded contents, here is our message:

This is a present from a small distant world, a token of our sounds, our science, our images, our music, our thoughts and our feelings. We are attempting to survive our time so we may live into yours. We hope someday, having solved the problems we face, to join a community of galactic civilizations. This record represents our hope and our determination, and our good will in a vast and awesome universe.

Jimmy Carter

President of the United States of America

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	Title & NASA Docket	Patent No.	Installation
Lester J. Owens, NASA/KSC William C. Jones, NASA/KSC	Rotational Joint Assembly for the Prosthetic Leg	4,038,705	KSC
Ronald J. Hruby, NASA/ACR Robert L. Wilson, Technology Learning Corp., Sunnyvale, Calif.	Twin-capacitive Shift Angle Encode with Analog Output Signal	4,040,041	ARC
Colonel W. T. McLyman, Gene W. Wester, CALTECH/JPL, Pasadena, Calif.	Phase Substitution of Spare Converter for a Failed One of Parallel Phase Staggered Converters	4,039,925	NRLO
Frank J. Nola, NASA/MSFC	Tachometer	4,039,946	MSFC
James R. Fenwick, George H. Karigan, Rockwell Inter. Corp. Rocketdyne Div., Canoga Park, Calif.	Improved Accumulator	4,039,000	MSFC
Daniel W. Gates, NASA/MSFC Yoshiro Harada, William R. Logan, John E. Gilligan, IIT Research Institute, Chicago, Ill.	Method of Preparing Zinc Othotitanate Pigment	4,039,347	MSFC
Donald C. Lokerson, NASA/GSFC	Speech Analyzer	4,039,754	GSFC
Harold E. Marsh, Jr., CALTECH/JPL, Pasadena, Calif.	Oil and Fat Absorbing Polymers	4,039,489	NRLO
James M. Zwiener, NASA/MSFC	Real Time Reflectometer	4,040,750	MSFC
Americo F. Forestieri, NASA/LERC Anthony F. Ratajczak, NASA/LERC Leroy G. Sidorak, NASA/LERC	Solar Cell Shingle	4,040,867	LERC
George A. Coffinberry Howard B. Kast, General Electric Co., Cincinnati, Oh.	Oil Cooling System for a Gas Turbine Engine	4,041,697	LERC
John Houseman, CALTECH/JPL, Pasadena, Calif.	Combustion Engine	4,041,910	NRLO
Leonard F. Deerkoski, NASA/GSFC	Pseudo Noise Code and Date Transmission Method and Apparatus	4,041,391 4,041,697	GSFC LERC
Roy E. Anderson, James R. Lewis, General Electric Co. Schenectady, N.Y.	Automatic Transponder	4,042,926	GSFC
Ralph F. Wuerker, Lee O. Heflinger, TRW Systems Group, Redondo Beach, Calif.	Spatial Filter for O-Switched Lasers	4,043,674	LERC
Donald L. Posey, NASA/LARC	Multi-Function Measuring Instrument	4,044,469	LARC
M. Kudret Selcuk, CALTECH/JPL, Pasadena, Calif.	Solar Energy Collection System	4,044,753	NRLO
Charles G. Miller, CALTECH/JPL, Pasadena, Calif.	Low to High Temperature Energy Conversion System	4,044,821	NRLO
Walter T. Appleberry, Rockwell Inter. Downey, Calif.	Load Regulating Latch	4,045,063	JSC
Richard Ravenhall, General Electric Co, Cincinnati, Ohio	Platform for a Swing Root Turbomachinery Blade	4,045,149	LERC
Melvin R. Jackson, General Electric Co., Schenectady, N.Y.	Directionally Solidified Eutectic Nickel-Base Superalloys	4,045,255	LERC
Porter R. Ryason, CALTECH/JPL, Pasadena, Calif.	Solar Photolysis of Water	4,045,315	NRLO
Melvin M. Saffren, CALTECH/JPL, Pasadena, Calif.	Apparatus for Photon Excited Catalysis	4,045,359	NRLO
Richard B. Kolby, CALTECH/JPL, Pasadena, Calif.	Direct Reading Inductance Meter	4,045,728	NRLO

Inventor(s) and Employer	Title & NASA Docket	Patent No.	Installation
David H. Schaeffer, NASA/GSFC James P. Strong, III, NASA/GSFC	Analog To Digital Converter for Two-Dimensional Radiant Energy Array Computers	4,045,792	GSFC
Wayne E. Arens, CALTECH/JPL, Pasadena, Calif.	Charge-Coupled Device Data Processor for an Airborne Imaging Radar System	4,045,795	NRLO
James F. Morris, NASA/YERC	Thermocouples of Tantalum and Rhenium Alloys for More Stable Vacuum-High Temperature Performance	4,045,247	LERC
William A. Mueller, George C. Hsu, Harold E. Marsh, CALTECH/JPL, Pasadena, Calif.	Aldehyde-Containing Urea-Absorbing Polysaccharides	4,041,233	NRLO

Jet Propulsion Laboratory

(California Institute of Technology) Pasadena, California

This is the fifth in a series of profiles of NASA field centers

NASA's Jet Propulsion Laboratory is unique among NASA field centers in two respects: Although the property and all furnishings and equipment belong to NASA, all personnel are employed by the California Institute of Technology, not by the U.S. Government. In other words, JPL operates for NASA as a giant contractor.

The physical make-up and atmosphere of the institution itself also are quite different from those of the other NASA centers in that JPL is unmistakably an academic establishment first and foremost, complete with graceful buildings, wide swaths of grass and flowers, stands of trees, fountains, and groups of casually dressed young people everywhere. The tools of the space trade are not in evidence on campus.

The interior of the buildings is another story, especially in such places as the tracking network control center, which would fit in nicely as part of the scenery in a sci-fi film such as "Star Wars." The

Keeping an Eye on the Universe—The tracking network control center at JPL, which maintains 24-hour communication with a variety of spacecraft traveling countless miles from Earth.

huge room is filled with computers, screens, flickering lights and tracking devices whose terminals reach deep into the solar system, continuously recording data being collected by satellites millions of miles from Earth—and ready to receive signals from other intelligent life forms anywhere in the universe.

No effort has been spared to make the building that houses the control center proof against almost every kind of natural disaster short of a major earthquake, against which no building can be fully protected. Even so, the windowless center's rugged construction far exceeds standards set for structures built in earthquake-prone Southern California.

Its power supply, for instance, is almost impregnable—electricity fed by a local supplier constantly charges large banks of batteries in the basement of the building. Should local electricity be cut off, the batteries would supply eight minutes of uninterrupted power; at the same time, two large Diesel generators installed in the building would take less than two minutes to be automatically activated and run indefinitely. Such precautions virtually guarantee that information being fed into the center from the far reaches of space will never go unrecorded.

Now, nearly 20 years after JPL became a leading participant in many of NASA's most important missions, the two recently launched Voyagers—the latest step in the U.S. program of planetary exploration —have become a prime responsibility of the NASA center.

The American space age actually began at JPL in 1958, when the United States launched Explorer 1, which eventually discovered the Van Allen radiation belts that surrounded the Earth. The 14-kilogram spacecraft continued transmitting until May 23, 1958, and reentered the atmosphere on March 31, 1970.

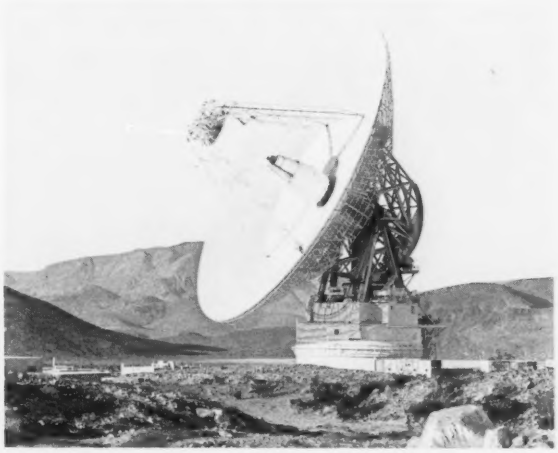
JPL became involved in the nation's first space venture because of the laboratory's expertise in rocket propulsion that began in the mid-1930s. Almost every rocket that flies today shares the common heritage of pioneering research at JPL by the late Professor Theodore von Karman of the California Institute of Technology and several graduate students who, according to one of them, "did rather odd experiments in a desolate spot in the Arroyo Seco north of Pasadena." That desolate spot is now the site on which JPL stands, covering about 66.8 hectares. Some 4,000 people are employed there.

On Dec. 3, 1958, two months after the creation of NASA, JPL was transferred from Army jurisdiction to the new civilian agency. The transfer provided for the laboratory to be operated by Caltech for NASA.

After Explorer 1, JPL, under NASA's leadership, led the U.S. missions to the Moon and the planets. Today, JPL's primary responsibility under Caltech's contract with NASA is exploration of the solar system with automatic spacecraft.

Among the laboratory's significant accomplishments are the successful Ranger and Surveyor lunar projects; the Mariner missions to Mars, Venus, and Mercury; and the recent Viking Mars mission.

Tranquil Campus—A view of the central mall garden and fountain at JPL with the nine-story central engineering building in background.



Link with Deep Space—This large tracking antenna (64 meters in diameter) is located at Goldstone, Calif. It is part of NASA's Deep Space Network of stations located around the world to maintain 24-hour radio contact with planetary and interplanetary space vehicles. A control center is located at NASA's JPL, which designed, built and manages the network for the space agency.

On April 1, 1976, Dr. Bruce C. Murray was appointed director of JPL, replacing the retiring Dr. William H. Pickering. Murray, a geologist and planetologist, has participated as coinvestigator and principal investigator on space-exploration missions managed for NASA by JPL.

The laboratory's current tasks include participation in the investigation of Mars by Vikings 1 and 2 during their extended mission, exploration of Jupiter and Saturn beginning in 1977, launching an ocean-survey satellite, SEASAT, and tracking and communications for the Jupiter spacecraft Pioneers 10 and 11 and the U.S.-West German Helios project, now studying interplanetary space near the Sun.

Recently, JPL began a new project called SETI (Search for Extraterrestrial Intelligence). Laboratory scientists and engineers are preparing a survey of 80 percent of the sky, seeking artificial radio signals from extraterrestrial civilizations.

Studies of future missions include a Jupiter Orbiter with atmospheric probe, and a mission to return samples of soil from Mars.

At JPL, space exploration is coupled with research and development across a broad spectrum of scientific and engineering disciplines.

Applying technological advances to solving problems on earth is a dedicated effort at JPL. More than 100 tasks are being studied and developed in medical science, pollution, sewage disposal, transportation, and energy.

Laboratory Director Lauds NASA-JPL Cooperation— Dr. Bruce Murray, JPL director, recently commented on the long and satisfactory relationship between NASA and the California laboratory, saying:

"In the coming years I look forward to a stronger relationship between JPL and the NASA Centers. There are technological partnerships that can be created for specific programs that will serve to provide higher levels of professional achievement. I personally will seek out those areas where the strengths and skills of engineering and scientific teams at JPL and the centers can be blended to the benefit of NASA and the enhancement of technical goals.

Other JPL installations include an astronomical observatory at Table Mountain, Calif., a rocket-test station at Edwards Air Force Base, Calif., and a launch-operations site at Cape Canaveral, Fla.

To provide spacecraft tracking and communications for deep-space missions, JPL operates the Deep Space Network (DSN) with stations in California, Spain, and Australia. Missions are run from the laboratory's mission control, the space flight operations facility. The scientific community also uses DSN facilities for radar and radio-astronomy experiments.

In addition to the projects already mentioned, JPL has project responsibility for:

- **SEASAT**, an Earth-orbiting satellite designed to survey the world ocean, scheduled for launch in 1978. The first of perhaps four such satellites will demonstrate to potential users and scientists just what can be learned about the sea from Earth orbit. Eventually SEASAT could become one element of a system to gather, process and distribute information on ice fields, wave heights and lengths, ocean currents, sea temperatures, and storms. The data provided could be of immeasurable value to a variety of users including oceanographers, maritime interests, weather forecasters, fishermen, offshore oil explorers, the U.S. Coast Guard and the U.S. Navy, and other government agencies and industrial firms.

- **Infrared Astronomical Satellite**—The Infrared Astronomical Satellite (IRAS), an international project involving the U.S., the Netherlands, and the United Kingdom will be jointly managed by JPL and NIVR, the Dutch Space Agency.

  The IRAS spacecraft is being designed and built in the Netherlands. The design and fabrication of the large 60-centimeter-aperture telescope will be the responsibility of the Ames Research Center. JPL, in addition to its role as project manager, will design and operate the scientific analysis facility that will produce an infrared sky map and a source catalogue, which may contain up to one million infrared sources.

  Launch from the Western Test Range at Vandenberg Air Force Base, scheduled for March 1981, will place IRAS in a polar orbit of 900-kilometer altitude.

- **The Deep Space Network**—The globe-girdling array of radio antennas and associated equipment called the Deep Space Network (DSN) is managed for NASA by JPL. Antennas at DSN

stations in California, Spain and Australia are continuously tracking and communicating with spacecraft exploring the solar system. They are currently collecting data from Pioneers 10 and 11; Helios 1 and 2; Vikings 1 and 2 (both orbiters and landers); the interplanetary probes Pioneers 6, 7, 8 and 9; and the two Voyagers enroute to Jupiter and Saturn.

- **Search for Extraterrestrial Intelligence**—The laboratory has undertaken a striking and unusual project—the search for extraterrestrial intelligence (SETI). SETI will conduct a five-year survey of 80 percent of the sky, searching for evidence of radio signals from intelligent extraterrestrial life. The project is a modest, beginning approach to one of the most profound questions mankind has ever asked: "Are we alone in the universe?"

  Project SETI will use two antennas, and advanced microcircuitry and data-processing techniques to survey the sky simultaneously across one million frequencies. The five-year survey is to begin in October 1978, after a two-year implementation period.

  Radio signals come to us from nearly every quarter of space, all apparently of natural origin. The objective of the SETI project will be to sort out and reject those natural signals and man-made radio-frequency interference, and to identify possible artificial signals from a source somewhere in the Milky Way galaxy.

- **Pioneer 10 and 11 and Helios**—In addition to its own flight projects, the Laboratory provides support to two major programs—Pioneer and Helios—managed by other institutions.

  The Pioneer 10 and 11 missions are managed by Ames Research Center; JPL is responsible for spacecraft tracking and data acquisition, and mission control and computing support.

  The Helios project is a joint U.S.-West German study of the sun, managed by Goddard Space Flight Center and the German Ministry for Research and Technology. Two spacecraft, launched on Dec. 9, 1974, and Jan. 15, 1976, have flown within 43.3 million kilometers (26.9 million miles) of the Sun. JPL provided spacecraft technical consulting and testing, and supports the program in tracking and data acquisition, mission control and computing, and technical and operations areas.

- **Jupiter Orbit Probe**—A mission to orbit the planet Jupiter and send an instrumented probe into the giant planet's atmosphere is in the planning stages.

  The mission, called Jupiter Orbiter Probe (JOP), will be assigned to JPL by NASA's Office of Space Science. JPL will design and build the spacecraft and control the mission; NASA's Ames Research Center will develop the probe.

  One JOP spacecraft will be launched by the Space Shuttle in January 1982. Arrival at Jupiter will come nearly three years later. The long flight time is necessary to allow the atmospheric probe carried aboard the orbiter to enter Jupiter's atmosphere on the sunlit side of the planet. The probe will be separated from the spacecraft 56 days before encounter with Jupiter. It will be aimed at an atmospheric belt—not at the planet's Great Red Spot.

  A variety of scientific instruments could be flown aboard JOP, including a new imaging sytem that makes use of charge-coupled devices (CCDs) rather than the vidicon tubes flown on past Mariner spacecraft. The CCD imaging system would provide a much greater spectral response than previous television cameras. It is expected that encounters with Galillean satellites will yield pictures with resolution on the order of 30 meters.

  Other projects include the development of solar electric spacecraft in coordination with NASA headquarters and with other NASA feasibility studies involving landing two roving vehicles on the Martian surface; a solar energy program directed at exploiting the Sun's energy; a conservation, fossil and geothermal energy program that focuses on near-term energy technologies; and a technology applications program covering a broad range of problems in the biomedical, environmental, and natural resources fields.

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